SIMILARITY IN SCHOOL TEXTBOOKS ON NATURAL SCIENCES FOR THE PRIMARY SCHOOL LEVEL: AN ANALYSIS OF TEACHING AND APPRENTICESHIP OF BOTANY IN THE LAST CENTURY IN PORTUGAL (1900-2000)

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Abstract

By analyzing school textbooks, we evidenced that Botany contents used for the teaching of Sciences cannot be isolated from both educational and curricular policies adopted in Portugal during the 20th century. Within schools, textbooks are important tools to conform shapes and contents applied in the pedagogical knowledge. The articulation of aspects related to the sequence and pace of knowledge transmission has momentous pedagogical and didactic objectives, which are made possible through properly devised activities and evaluation mechanisms for such acquisitions.
With this perspective in mind, such objectives can allow us to know the subjacent pedagogical and curricular ideology, as well as the way through which the learning and apprenticeship process is understood. Such process takes place within classrooms and plays an important role for teachers and students.
The present study, based upon the PhD thesis on Children Studies (*Botany within school textbooks for Primary and Basic teaching levels [1st cycle] in the 20th century in Portugal)*, aims to analyze the importance Botany is given in Portugal in school textbooks that cover Natural Sciences for Primary School students in the last century.
Our attempt to know how botanical topics were differently adopted throughout time in the school textbooks relied on 11 principles: *Shape; Kingdoms; Classification; Organs; Root; Stem; Leaf; Flower; Fruit; Reproduction;* and *Dimension*. Such appreciation, based upon a methodological approach that analyses content, upon the establishment of *a posteriori* categories, and upon the cluster analysis with dendrogram build-up, contributes to encounter primary sources related to content, which engulf curricular, pedagogical and didactic orientations. These orientations bear educational, curricular and didactics policies, as well as educational and scientific values suggested herein.
Results have shown that despite the variation on terminology found in school textbooks (including the ones from Natural Sciences, Natural-Geographic Sciences, Physical and Social Environment, and Environment Studies), various aspects evolve, such as a decreasing level of complexity, similarity and specificity relationships amongst school textbooks, and the maintenance of Botany content.

Keywords - Botany, teaching of Sciences textbooks, primary school.

1 INTRODUCTION

As scientific knowledge on biological classifications (namely Taxonomy, Systematics, Nomenclature, Classification, History of classification systems, Taxonomical schools and so forth) evolved, different governments throughout the last century drove the introduction of new Botany syllabi within the teaching of Nature Sciences at the mandatory and basic schooling in Portugal to overcome certain gaps that existed in such country. Thus, Botany teaching gets more complex with the emergence of new realities, curricular and didactic changes that focus on such dimensional metamorphoses. As we outlined the current work to Botany teaching, which is also known as school Botany, we did not forget the fact that disciplinary subdivisions within Science Education investigations ultimately establish fewer differences than those general orientations.

School textbook analysis evidences that Botany contents within Science teaching cannot be understood without considering educational and curricular policies in the last century in Portugal. School textbooks are crucial for schools as they conform to shapes and content found in pedagogical knowledge; thus, they integrate aspects related to the sequence and pace of such knowledge with activities proposed and ways of evaluating acquired goals. School textbooks play, then, important pedagogical and didactic roles [1]. By viewing this way, they let us have access to the subjacent curricular and pedagogical ideology, as well as the way we understand the teaching-learning process that takes place within classrooms and the role given to students and teachers.

1.1 Objectives

Our study deals with Nature Sciences teaching based upon school textbooks, on a diachronic approach whose main goal is to focus on Botany. By considering some premises [2], we aim to: Contribute to understand Botany in Basic School textbooks, throughout the 20th century in Portugal; Understand how important school textbooks are for the teaching of Nature Sciences, specially Botany; Interpret the evolution of Botany concepts, content and methodological approaches found in school textbooks, as well as the way such things influenced and have influenced the teaching of Nature Sciences at the Basic Education in Portugal.

1.2 Study objects

The pedagogical text corpus upon which our study will be developed includes Nature Sciences textbooks. Textbook collection was carried out from a huge sample of publications targeted to Basic School students. Only 25 books were picked from that sample (Table 1). Selection was guided with both quantitative and qualitative criteria. We tried to keep books for all the historical period taken by considering publication dates along with the new entry of program texts.

Table 1. Sample of 25 school textbooks (in Portuguese).

Year	Author, Title and Teaching Level
1903	Cardoso; Rudimentos de Sciências Naturaes
1907	Almeida e Cardeira; Ligeiras Noções de Sciências Naturaes
1910	(s. a.); Sciências Naturaes; 9.ª edição
1914	Araújo; Breves Noções de Sciências Naturais
1916	Andrea e Magno; Sciências Naturais
1920	Borges; Sciências Naturais
1922	Vasconcelos; Sciências Histórico-Naturais e Físico-Químicas; 3.ª,4.ª e 5.ª classes
1925	Júnior; Simples Noções de Sciências Naturais
1928	Vasconcelos; Sciências Físico-Naturais Higiene e Agricultura; 3.ª e 4.ª classes
1930	Santos; Elementos de Sciências Naturais; 4.ª classe
1933	(s. a.); Ciências Naturais; 4.ª classe
1942	Barros; Ciências Naturais
1950	Pinho; Ciências Naturais; 4.ª classe
1960	Carvalho; Ciências Geográfico-Naturais; 4.ª classe
1968	Lopes e Rodrigues; O mundo que te cerca e de que fazes parte. Ciências Geográfico-Naturais; 3.ª classe
1974	Ramiro; Ciências Geográfico-Naturais; 4.ª classe
1982	Carvalho; Por caminhos não andados... Meio Físico e Social; 4.º ano
1984	Monteiro; Ecos de Portugal. Meio Físico e Social; 4.º ano
1986	Moreira, Moutinho e Oliveira; Bom Dia! Meio Físico e Social; 4.º ano
1989	Pinto e Carneiro; O Bambi descobre... Meio Físico e Social; 2.º ano
1990	Ramos e Ramos; Coca-Bichinhos 4. Meio Físico e Social; 4.º ano
1995	Monteiro; Magia do Saber. Estudo do Meio; 4.º ano
1996	Barros e Nunes; Crescer com os outros 2. Estudo do Meio; 2.º ano
1997	Monteiro; Saber quem Somos. Estudo do Meio; 3.º ano
1998	Borges, Lima e Freitas; Andorinha Turrinha 4. Estudo do Meio; 4.º Ano

Eleven appreciation principles were analyzed: Shape; Kingdom; Classification; Organs; Stem; Root; Leaf; Fruit; Flower; Reproduction; and, Dimensions. Analytical categories were subdivided into four levels of importance: Level 1, Level 2, Level 3, and Level 4. In such levels, we could integrate the huge diversity of information found in our sample. Thus, in Table 2 we point out the procedures taken as we built analysis categories and their respective levels of importance.

Table 2. Appreciation principles and analysis levels.

Principles	*Levels*			
Shape	*L1*	*L2*		
Kingdom	*L1*	*L2*		
Classification	*L1*	*L2*	*L3*	
Organs	*L1*	*L2*	*L3*	
Root	*L1*	*L2*	*L3*	*L4*
Stem	*L1*	*L2*	*L3*	
Leaf	*L1*	*L2*	*L3*	
Flower	*L1*	*L2*	*L3*	*L4*
Fruit	*L1*	*L2*	*L3*	
Reproduction	*L1*	*L2*	*L3*	*L4*
Dimensions	*L1*	*L2*	*L3*	

1.3 Analytical procedures

So that we could know how Botany was taught in school textbooks used throughout the 20th century in Portugal, we carried out a document investigation based upon bibliography, legislation and school textbooks. We could privilege the establishment of interdependent relationships between theoretical buildup and empirical data obtained in a continuous struggling and mutual effort situation.

Thus, a set of tools were used to reach such referred objectives:

a) Content analysis consists essentially of a systematization effort so that such information gets analyzable. It engulfs relatively complex procedures. Several phases are involved, and these relate to category determination and analysis units to group different Botany features found in Basic Education school textbooks.

b) Cluster analysis is an exploratory tool to analyze data to solve classification problems. It is also known as taxonomic analysis and it tries to identify homogeneous groups of cases within a population. There is a relationship between case similarity and distance shown in graphical representations (e.g., in dendrograms). Similar cases share a high level of similarity.

2 SIMILARITY AMONG SCHOOL TEXTBOOKS

So that we could realize how textbooks are similar or not according to different appreciation principles, we carried out a cluster analysis from our analysis matrix to build an overall perspective on book similarity. Publication years and their relationship with the appreciation principle were considered along with their respective variables.

By looking at Fig. 1, we can see the existence of five significant clusters or homogeneous groups of school textbooks, which translate the similarity among different books. The first cluster consists of seven cases; the second cluster consists of four cases; the third cluster has five cases; the fourth cluster has four cases; and, the fifth cluster has five cases. The first cluster evidences the Shape feature found in textbooks from 1900 to 1920; the second cluster evidences Shape particularities found in textbooks from 1920 to 1940; the third, the same feature in the period 1940~1980; the fourth cluster evidences such Shape feature in textbooks from 1980 to 1990; and, finally, the fifth cluster engulfs the same feature in the period 1990~2000.

In such relationship, we cannot omit particular cases found in a textbook dated back to 1925 (found in the first cluster), and in textbooks from 1989 to 1990, with position change in clusters four and five.

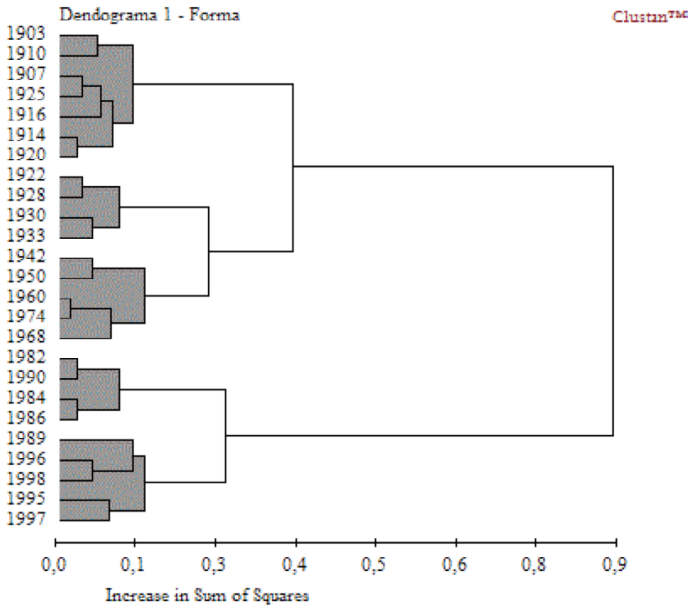

Fig. 1. Shape.

The current analysis suggests that such relationships originate form the similarities among school textbooks, i.e. we admit, by considering our matrix, that Nature Sciences school textbooks for the Basic Education level throughout the first two decades of the 20th century in Portugal are similar in Shape, with the same denomination (Natural Sciences, or *Sciências Naturais* in Portuguese). Teaching was given in classes, with no images in the text, except for the 1910 compendium in which images take a smaller room than the text itself. Moreover, didactic activities that favor memorization, with questionnaires and summaries, are found as well.

Textbooks of the following two decades are similar with a general denomination of Natural Sciences (*Sciências Naturais*), though in 1933 a school textbook called *Ciências Naturais* was written (Basic Education level). Teaching was given in classes; images took a smaller room than texts, and there were no didactic activities. Textbooks from the decades 1940~1970 are similar in relation to Shape, although different denominations, such as *Ciências Naturais* and *Ciências Geográfico-Naturais* (Natural and Geographical Sciences), are found. All of them encompass the Basic Education level, with teaching in classes, and colored images that are the same size of texts. Didactic activities on memorization and experimentation are found. School textbooks from the 1980s are similar and are called *Meio Físico e Social* (Physical and Social Environment). Teaching was given according to school years. Images are colorful and are the same size of texts. In the 1989 textbook, images are bigger than text, and didactic activities on memorization, experimentation, research, mural elaboration and herbaria build-up are found. Textbooks from the 1990s are similar and are entitled *Estudo do Meio* (Environment Study). They cover Basic Education levels, and teaching was given in school years. Colored images took the same size of text. Didactic activities on memorization, experimentation, research, mural elaboration, herbaria build-up and field and group work are also found.

3 SCHOOL BOTANY: APPRECIATION PRINCIPLE ANALYSIS

Relatively to Fig. 2 and to all appreciation principles that see school Botany on a global view, we can see the existence of five significant clusters or homogeneous groups of school textbooks, which bear the similarity found among different books. The first cluster has 19 cases; the second cluster has one case (the 1930 book); the third cluster has one case (the 1922 book); the fourth cluster has also one case (the 1928 compendium); and, lastly, the fifth cluster has three cases.

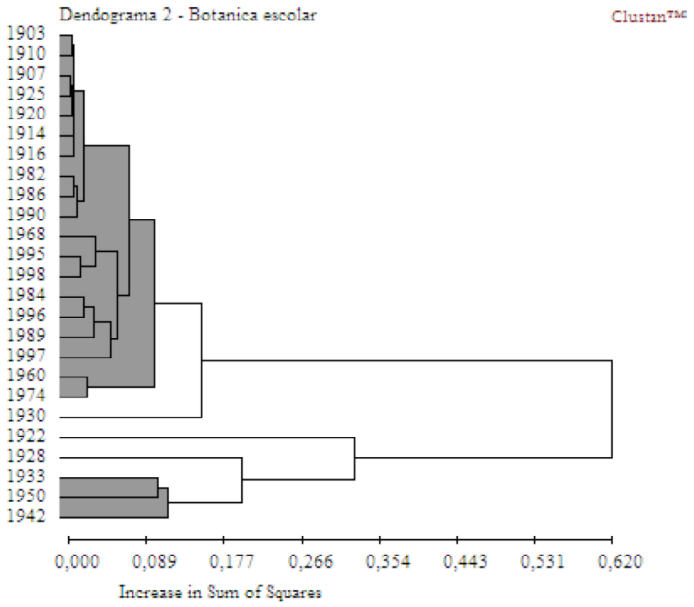

Fig. 2. School Botany.

According to Fig. 2, the first cluster evidences botanical features found in school textbooks for the first two decades in the 20th century, from 1900 to 1920 (including), in the 1925 book, and in the last four decades of the 20th century, from 1960 (including) to 2000. The second, third and fourth clusters evidence particularities of the school Botany in school textbooks for the 1920s, from 1920 to 1930 (including). The fourth cluster corroborates features of the school Botany found in school textbooks from 1930 t0 1960.

4 FINAL CONSIDERATIONS

The following considerations may be thought of by looking at the similarity relationships among school textbooks, the appreciation principle of Shape, the school Botany and the analysis period:

Variation of terminology in school textbooks. A first look derives from the analysis taken and it engulfs the different typologies used to identify compendia, from *Sciências Naturais*, *Ciências Naturais*, *Ciências Geográfico-Naturais*, *Meio Físico e Social* to *Estudo do Meio*. Such changes evidence approach modifications as such school textbooks are Nature Sciences books. In the beginning, these denominations versed upon a disciplinary approach – *Sciências Naturais* and *Ciências Naturais* –, and afterwards they were replaced by a disciplinary annex – Nature Sciences with Geography: thus, *Ciências Geográfico-Naturais.* Later on, a new approach considered the environment – in our point of view, in such phase there is a transition from a disciplinary approach to a contextualized approach. Different conceptions of the environment are considered: from a pre-analytical syncretism to a post-analytical, systemic view [3]. In such approach, the specific context is the environment, initially the Physical and Social Environment, and later on, the Environment Study.

Simplification of Botany content. Such changes on textbook designation evidence that, specifically in the Botany case, whereas such science gets more complex with the generation of new investigation areas that bring up new knowledge and specification, at school Botany gets simpler, as its content tend to evidence gaps in the new scientific themes. We did not verify new knowledge being absorbed into the school Botany [4].

Possible similarity relationships among school textbooks throughout the analysis period. If we analyze Fig. 2, and separate cluster #1 from the other clusters, we can see that there is a new chronological continuity, which separates our sample into two similar textbook clusters. These two groups are distributed according to three distinct periods: one, from 1900 to 1920 (including) – twenty years –; another, from 1920 to 1960 – forty years –; and, also, a period from 1960 (including) to 2000 – forty years.

Periods 1900~1920 (including) and 1960 (including)~2000 correspond to the first cluster. As we can see by observing Fig. 2, there is a temporal gap between these two periods included in the same cluster. By verifying Fig. 2, we can notice that such gap is overcome in the second cluster (1920~1960). Thus, we infer that school textbooks keep similarity relationships and keep Botany content within these three described periods.

Similarity specificity among school textbooks. Results have evidenced some specificity in similarity relationships among school textbooks. Thus, we can infer, from the five clusters shown in Fig. 2, that those cases belonging to the first cluster lead us to think of a similarity when approaching school Botany in separate historical moments (for forty years); i.e., results have shown that Botany contents are similar. School textbooks, then, keep the same content throughout the first twenty years and the last forty years of the 20th century in Portugal. School textbooks belonging to the fifth cluster have suggested similarities regarding the school Botany throughout a thirty-year period, which correspond to the 1930s~1950s. In these thirty years, the approach taken for Botany makes school textbooks more specific. Results have also evidenced that such period has specific characteristics and distinct approaches for the school Botany taught.

Relatively to the other three clusters, we have to carry out a more detailed analysis, as Fig. 2 brings isolated clusters. Such characteristic evidences unique particularities found in school textbooks, as we consider the historical period and the set of analysis principles (which mirror Botany content found in school textbooks). School textbooks keep their own identity and do relate to other compendia. A possible analysis relates to the fact that school textbooks from 1922 to 1928 were written by the same author. That would make them specific and a difficult relationship with the other could be established. However, we did not find any explanation for that (even though they belong to the same author, that does not mean they cannot be related one to another).

Botany content conservation. By taking a look at Fig. 2, we can infer that our results have evidenced a relational trend among teaching programs and school textbooks from our school Botany sample. Thus, we can infer the following ideas: rudiments of natural sciences did not constitute a course, but only a series of general skills that might be taught to children, being teaching/instruction carried out through intuitive processes with the presentation of their own objects, or with drawings; there was a tendency to focus on the skills to read, write and count – thus, the three first classes emphasized the excellence of the basic education level; the use of methods based on observation and experience infers a school Botany founded on a Lesson of Things; the consciousness on the relationship with the surrounding environment, as the contact with plants regionally found and their utilization may satisfy children's curiosity, might lead to obtain useful knowledge for practical life; availability of Botany teaching through different approaches, such as plant collection carried out by students, vegetal museum build-up, botanical garden and school garden creation that emphasized a more objective study of nature; the need for students to learn how to observe environment and think deeply over it, with the hope that by doing so they can conclude that people live and organize their lives differently (interdependence of men and surrounding environment); transformation of Nature by labor, personal experiences, interest for distant places are also situations that might intend to focus and systematize ideas from the references obtained in the surrounding environment with the inference to morphological principles and the national wealth – these can be labeled as a manipulative school Botany. Botanical content related to transformation, defense and conservation of the environment may lead us to think of a preventive Botany.

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